Space Weather Technical Forecast

Issued on Saturday, 22 January 2022 at 12:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight Chance of G1/Minor Storm intervals from CME arrivals throughout. Active electron fluence.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Very Low in the past 24 hours, with no significant X-ray flares recorded. There are now just two sunspots on the visible disc, both small and simple unipolar groups. Ex-2929 over the northwest limb is still showing some activity however. No Earth-directed CMEs have been observed in available imagery in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR and ACE at L1, showed the arrival of a weak CME, the effects of which are now waning. Wind speed was at slightly elevated levels, just above 400km/s, with a weak enhancement around 21/1310UTC to near 500 km/s at times. Wind speeds are now just above 400 km/s. Density has been largely near average. The Total IMF (Bt) has been weak, but showed a kick to 7nT with the weak CME arrival. The north-south component (Bz) was also weak but has been predominantly southward directed. The phi angle was mostly negative (towards the Sun). Geomagnetic activity has been Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was just slightly elevated, but continued to slowly decline from the recent S1 event. High energy electron flux (greater than 2MeV), is at mainly High levels, with a peak value of 4000 pfu at 21/1340 UTC, but dropped to mostly Moderate levels overnight UTC. Electron fluence persisted above the 1e8 Active threshold, with a slight falling trend, and an observed value of 1.41e8 integrated pfu recorded at 22/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: There is initially a very slight but diminishing chance of isolated M-class flares, however this risk soon eases as ex-2929 rotates further away from the western limb. Very Low solar activity is then expected, with a slight chance of C-class flares.

Solar Wind / Geomagnetic Activity: There are possible CME influences on the first three days of the forecast period. Weak CME effects are currently waning. A further CME from 19th Jan is possible on the 23rd. On the 24th two CMEs, one from the 20th and another from 21st Jan, could also possibly glance past Earth. In the absence of the CMEs above, solar winds are expected to initially be background to slightly elevated, with an increasing chance of high speed stream influence developing from the second half of 23 Jan onwards.
The resultant forecast is very low confidence in timing and phasing of G1 risk, but higher for this being the maximum attained geomagnetic activity. In the absence of any CMEs, Quiet to Unsettled activity should give way to more frequent Unsettled periods, with a chance of isolated Active intervals, from later Day 2 (23rd) associated with coronal hole influence.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to continue to slowly decrease in the first half of the forecast period. The chances of any further enhancements should gradually fall to very low probabilities as ex-2929 rotates further

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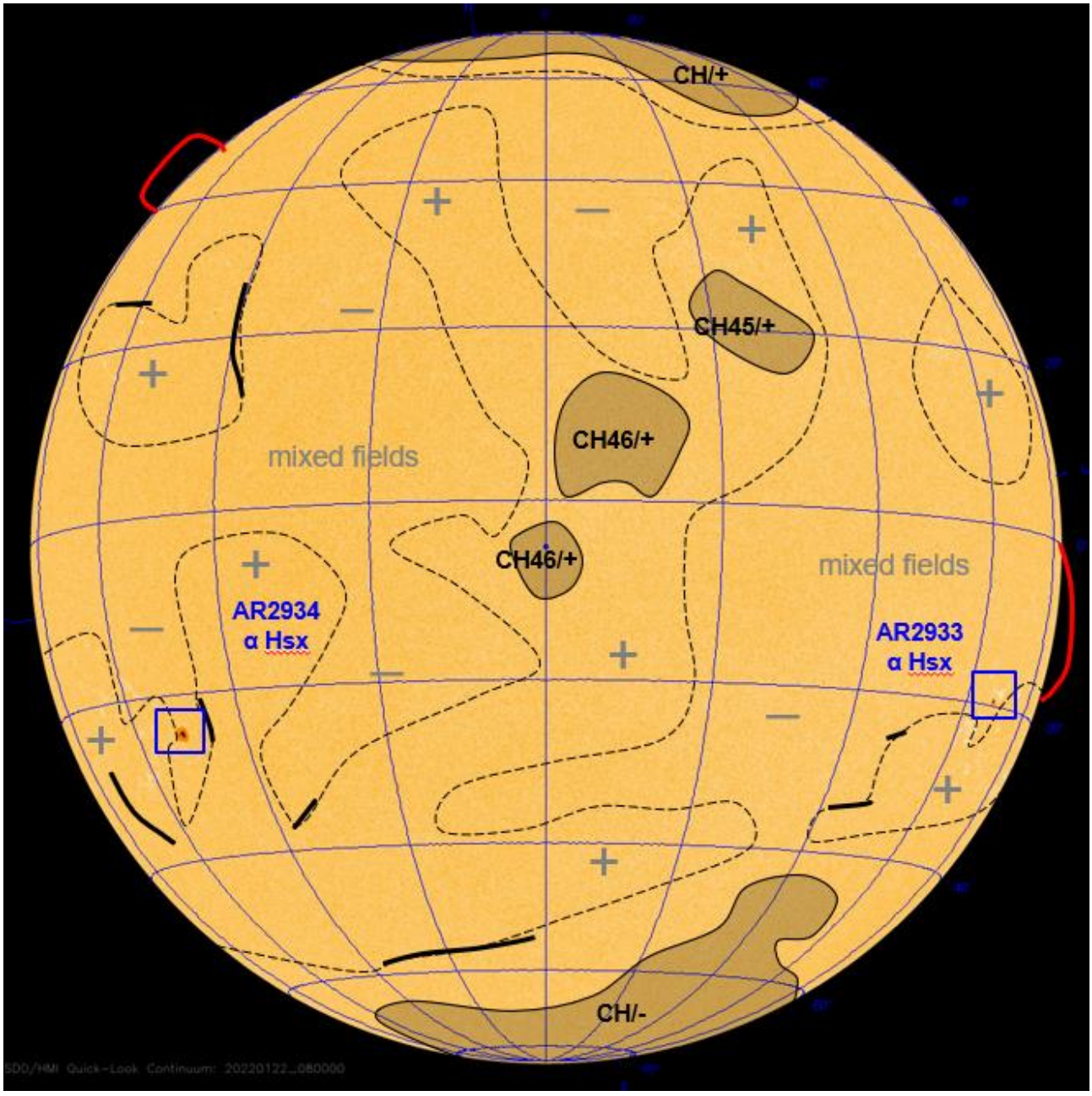
away.
The high energy electron flux (greater than 2MeV) is expected to continue to reach High flux levels at the diurnal peak at first. The forecast is low confidence however, with the likelihood of interruptions from CME arrival and perhaps the more assured reset to lower levels from CH45 and CH46 from later Day 2 (23 Jan). The 24-hour fluence is forecast to persist above the Active threshold initially, but with an increasing chance of dropping below this level into the new week.

Figure 1. Solar Analysis Valid 22/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are numerous CME influences possible in the forecast period. Weak CME effects are currently waning at Earth. A further CME from 19th Jan is then expected to move across Earth on the 23rd. This is a slower and weak CME, but with relatively higher confidence of arrival. The CME associated with the M5 flare on 20th is modelled as missing Earth, however a further CME, associated with an ensuing filament eruption in the southwest quadrant, is modelled as potentially brushing Earth on the 24th. Finally, a filament eruption and subsequent CME near the SE limb on 21st Jan, could also possibly brush past Earth on 24th, but this is considered a very low probability as the vast bulk of the ejecta is directed away from Earth.

In the absence of the CMEs above, solar winds are expected to be background to slightly elevated in the short term, with an increasing chance of high speed stream influence developing from the second half of 23rd onwards, from CH45 and CH46. These features are similar to the previous rotation, lending some confidence to the timing of the arrival of this feature.
The resultant forecast is very low confidence in timing and phasing of G1 risk, but higher for this being the maximum attained geomagnetic activity. In the absence of any CMEs, Quiet to Unsettled activity should give way to more frequent Unsettled periods, with a chance of isolated Active intervals, from later Day 2 (23rd) associated with coronal hole influence.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	20	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
19/1837	Partial	Filament	S16 W17	288	23/1500 UTC	Low confidence.
20/1642	Partial	Filament	S02 W59	478	24/1200 UTC	Likely to pass ahead of Earth

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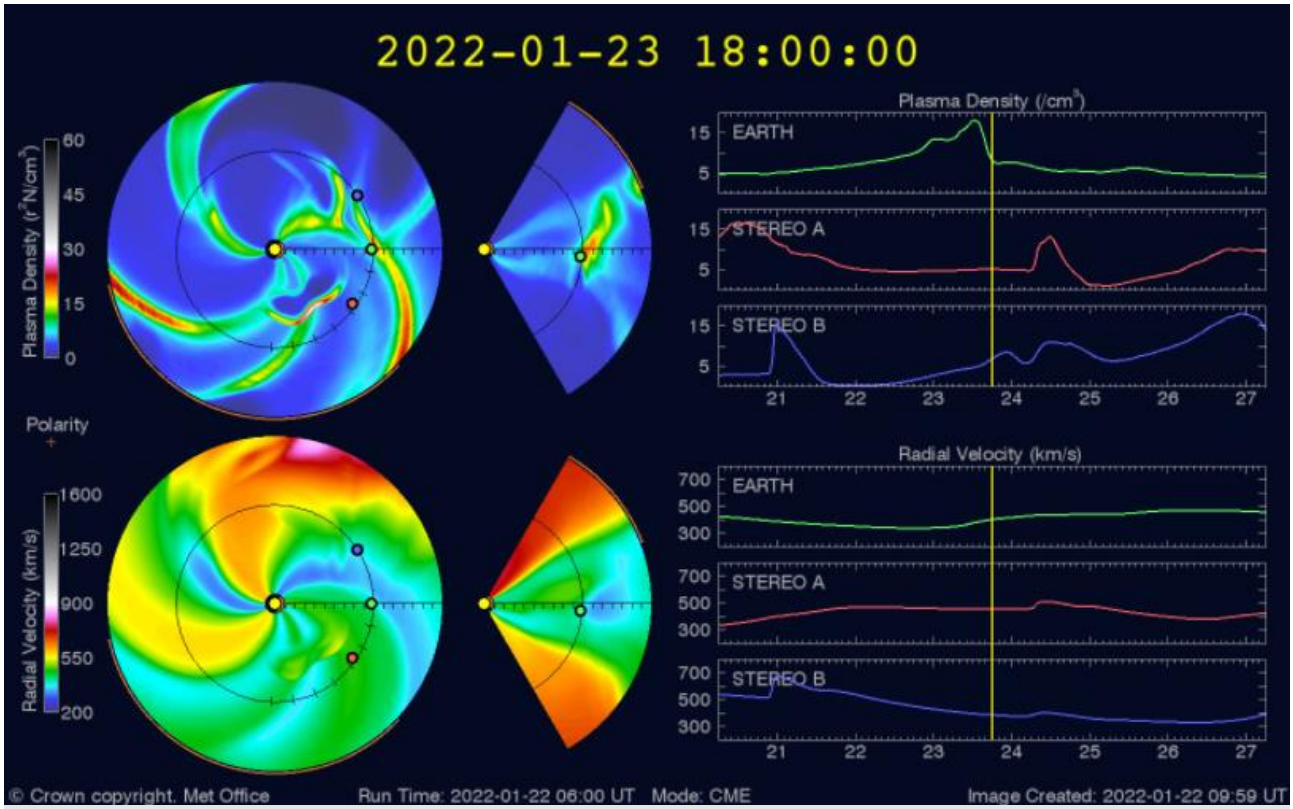
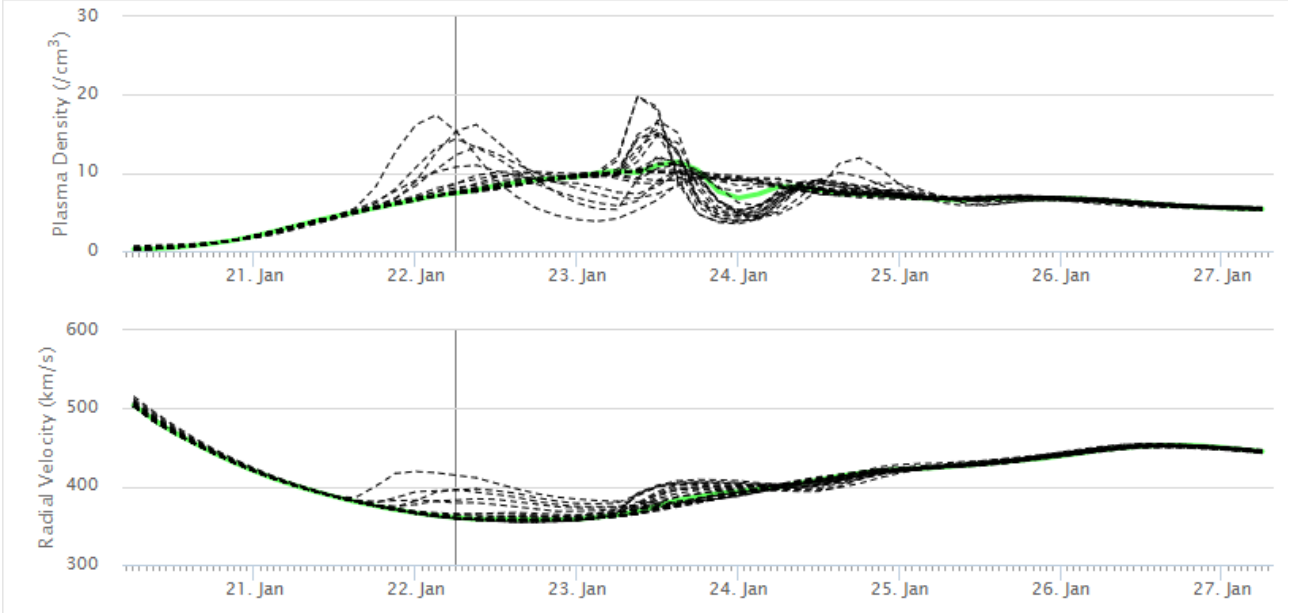
Figure 2: MOSWOC Enlil model and ensemble, showing various CMEs potentially arriving at Earth





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Radio Blackouts - X-Ray Flares:

There are now just two front-sided sunspot regions on the disc, and neither is likely to prove capable of significant flares in their current form. Ex-2929's recent transit beyond the west limb means there is still initially a very slight but diminishing chance of M-class flares, however this risk soon passes into the UTC weekend. Given the expected lack of returning and newly-developed regions near the eastern limb of the Sun, the chances of further significant flares are considered increasingly slim.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	2	1	1
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The assumed continued presence of Ex-2929 beyond the western limb is maintaining the very slight risk of further S1-level enhancements at first in the forecast period, however this risk should soon decline with continued far-side progression of this group.
With Ex-2929 gone, the remaining sunspot groups are unlikely to sustain such risk levels, with a decay to background level of risk most likely by the end of the UTC weekend.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	2	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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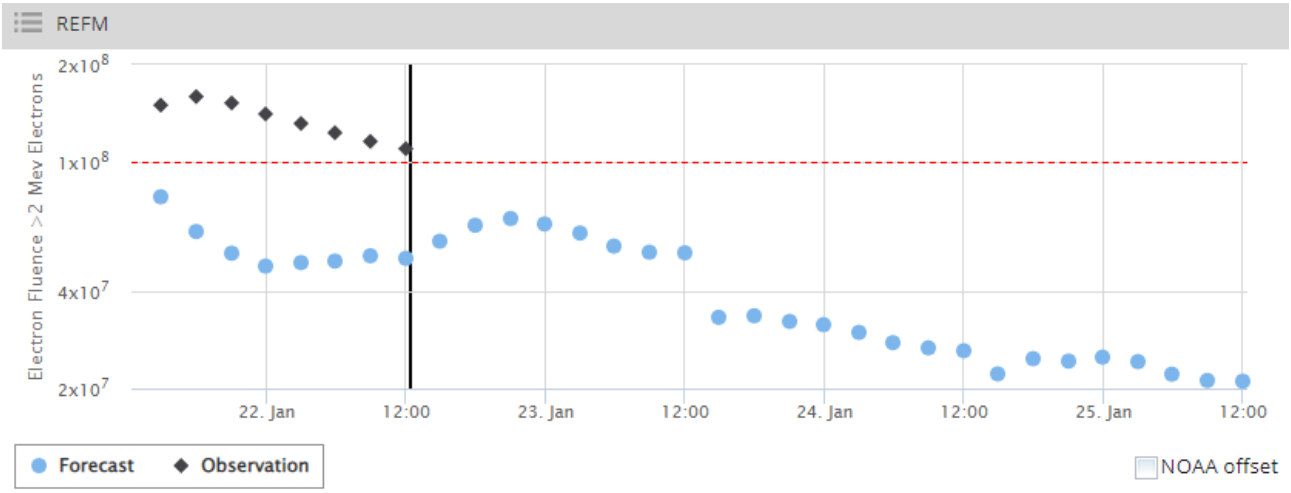
High Energy Electrons Event (≥ 2MeV):
The high energy (greater than 2 MeV) electron flux, as measured by GOES-16 at GEO, has been reaching High levels after recent fast wind and CME enhancements. The peak level yesterday is likely to represent the highest level in the period. However, detail is very low confidence given the forecast of several transients, the timing and phasing of which are difficult to pin down. Of greater confidence is the resetting potential of the coronal hole high speed stream that should take effect from later Day 2 (23 Jan), meaning that the initial Active fluence levels should slowly decline, becoming a Chance of Active into Day 3 (24 Jan), with any re-enhancement unlikely until later in the period, or just after this 4 day period.
Again because of the heavily transient-influenced forecast, the signal from REFM should be considered low confidence, however the general downward trend is accepted.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	100	70	40	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: REFM model, showing a declining trend. Should be treated with caution, as it doesn't have the forecast CME arrivals as an input. The trend is likely correct however.



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